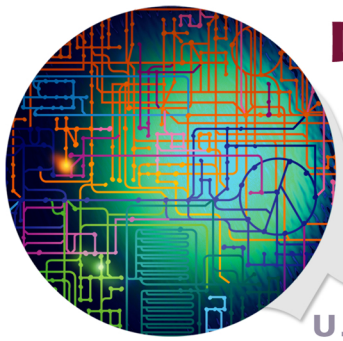

DOE GENOMICS:GTL

SYSTEMS BIOLOGY FOR ENERGY AND ENVIRONMENT

OFFICE OF SCIENCE
U.S. DEPARTMENT OF ENERGY

This document

has been updated.

New file is available at

http://doegenomestolife.org/pubs.shtml

November 2005

DOE Office of Science: Continuing a Tradition of Achievement

In 1986 the DOE Office of Science launched the Human Genome Project to understand, at the DNA level, the effects of energy production on human health. The benefits from this project far exceed the original goal. Today, DOE is poised to take the next vital steps to translate the genetic code in DNA into a new understanding of how life works and apply those biological processes to serve its challenging missions. DOE has the historic perspective, track record, and infrastructure to conduct the large-scale, complex, mission-driven science needed to achieve these goals. In the effort to understand biological systems, these assets and the Genomes to Life program will complement and extend the capabilities and efforts of the National Institutes of Health, the National Science Foundation, and other agencies and institutions around the world.

Contacts for technical programmatic information on GTL

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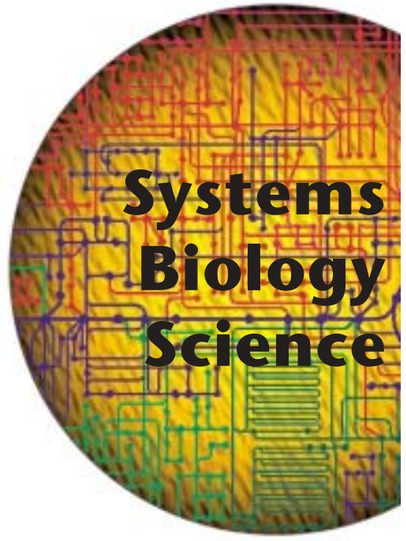
Copies of the April 2001 roadmap, along with associated documents, meeting reports, and image gallery, are downloadable via the Web:

- DOEGenomesToLife.org

Future materials published about GTL may be requested from:

- Human Genome Management Information System
  865/576-6669, Fax: /574-9888
  mansfieldbk@ornl.gov

GENOMES to LIFE
BIOLOGICAL SOLUTIONS FOR ENERGY CHALLENGES
U.S. Department of Energy
INNOVATIVE APPROACHES ALONG UNCONVENTIONAL PATHS



Realizing the Potential of the Genome Revolution

October 2002

Genomes to Life and Systems Biology Science

The revolution in biology triggered by the Human Genome Project now promises far-reaching benefits to the nation and environment. Today, scientists have in hand the complete DNA sequences of genomes for many organisms—from microbes to plants to humans. For the first time, we can begin to explore the "operating systems" of life written into these genetic codes and put them to use. At the leading edge of this great scientific frontier is the Genomes to Life (GTL) program, whose overarching goal is to understand and use the diverse capabilities of microbes to target critical Department of Energy (DOE) mission challenges in energy security, global climate change, and toxic waste cleanup (see goals at right).

A "Systems-Level" View

Although completed genomes provide "parts lists" for many microbes, we still have very little understanding of how these components create, sustain, and reproduce living systems. Obtaining this knowledge, a critical first step to harnessing microbial functions, requires extending the paradigm of comprehensive, whole-genome biology to the level of whole systems. In taking this approach, GTL uses DNA sequences as a departure point for explorations into the complex interactions of many levels of biological information, including genes, proteins, multimolecular assemblies ("molecular machines"), and the intricate labyrinth of pathways and networks in which they interact. These studies will enable an integrated and predictive understanding of how living cells function and respond to environmental changes. Revolutionary applications of this knowledge include clean, biology-based energy (e.g., methane or hydrogen), far more effective environmental cleanup with dramatic cost reduction, and reduced atmospheric carbon dioxide to mitigate global climate change.

Advanced Technology and Computing

Just as the HGP required capabilities far beyond those available at its inception, concurrent technology development is needed to reach all GTL goals. Substantial efforts will be devoted, for example, to improving technologies for characterizing proteins and molecular machines, localizing them in cells and tissues, carrying out high-throughput functional assays of complete cellular protein inventories, and sequencing and analyzing microbial DNA taken from natural environments.

Further, the wealth of data to be collected in GTL studies of dynamic living systems will be assimilated, understood, and modeled on the scale and complexity of real living systems and processes, an enormous task requiring the development of advanced computational methods and capabilities. These advances will complement experimental and theoretical biology to build a larger, intellectually richer, and more agile biology enterprise. These synergies are critical for making biological knowledge widely available and for stimulating new biological discovery and understanding.

GENOMES to LIFE

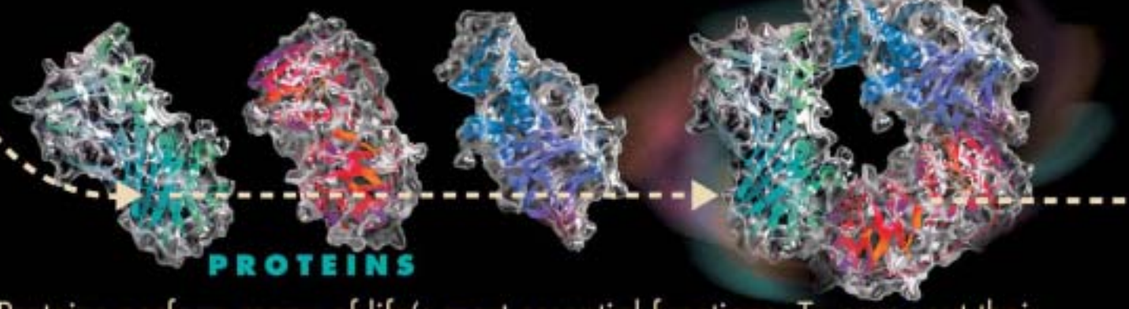
BIOLOGICAL SOLUTIONS FOR ENERGY CHALLENGES

INNOVATIVE APPROACHES ALONG UNCONVENTIONAL PATHS

U.S. DEPARTMENT OF ENERGY

DNA SEQUENCE DATA FROM GENOME PROJECTS

Genes and other DNA sequences contain instructions on how and when to build proteins



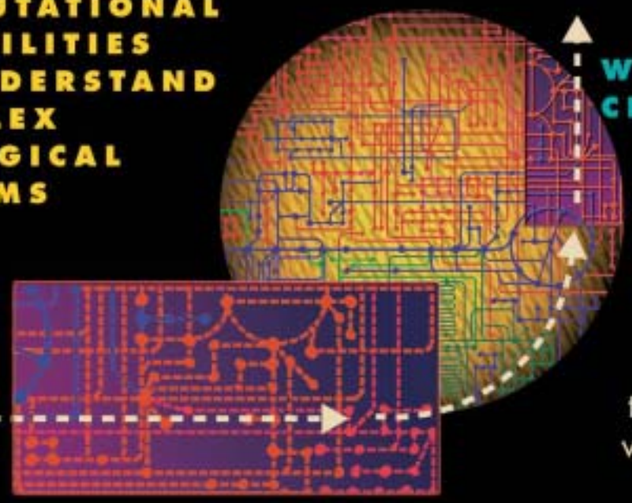
PROTEINS

Proteins perform many of life's most essential functions. To carry out their specific roles, they often work together in the cell as protein machines.

goal IDENTIFY PROTEIN MACHINES

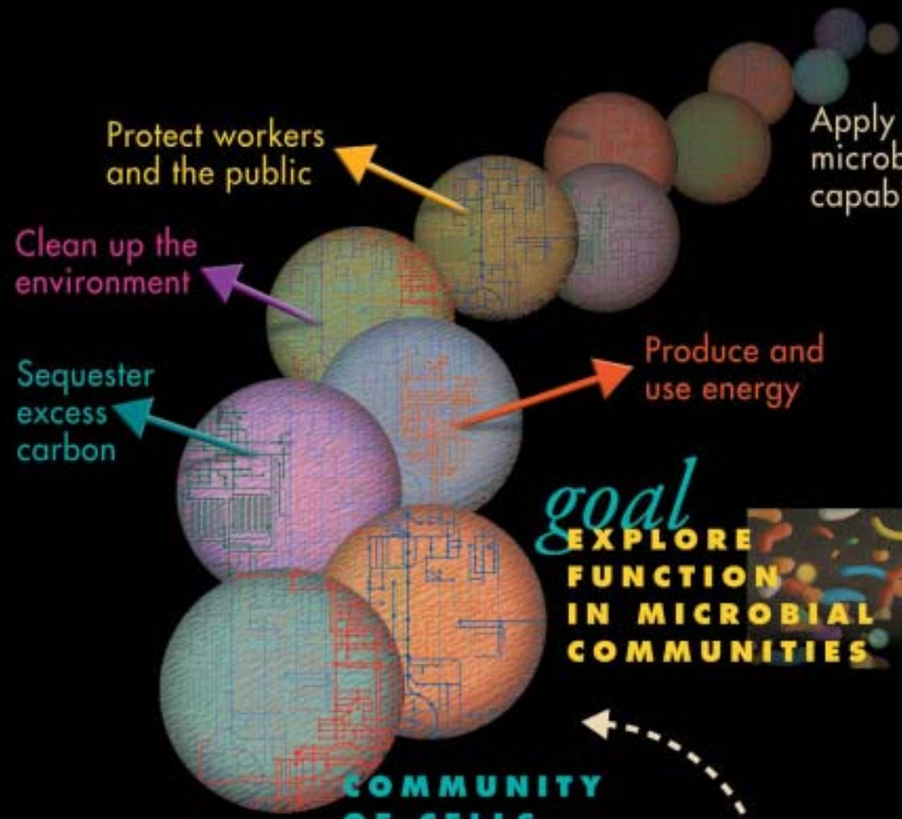
goal CHARACTERIZE GENE REGULATORY NETWORKS

goal DEVELOP COMPUTATIONAL CAPABILITIES TO UNDERSTAND COMPLEX BIOLOGICAL SYSTEMS



WORKING CELL

Many protein machines interact through complex, interconnected pathways. Analyzing these dynamic processes will lead to models of life processes.



COMMUNITY OF CELLS

goal EXPLORE FUNCTION IN MICROBIAL COMMUNITIES

URL *DOEGenomesToLife.org*

10/02